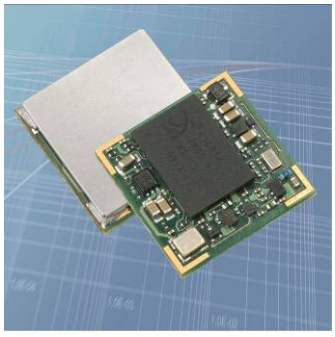
GPS Receivers A1084

A Description of Vincotech's
GPS Receiver Modules A1084-A/-B

User's Manual

Version 1.0
Hardware Revision 01



Revision History

Rev.	Date	Description
0.1	08-22-08	Initial Draft
0.2	12-04-08	Second Draft
0.3	12-17-08	Third Draft
1.0	01-26-09	First release
	mm-dd-yy	

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1 Introduction

Vincotech's GPS modules A1084-A and A1084-B are highly integrated GPS receiver modules that can be used as SMT components. They are capable of receiving signals from up to 20 GPS satellites and transferring them into position and timing information that can be read over a serial port. This new generation of GPS modules combines small size and high-end GPS functionality at low power consumption:

- Operable at 3.3V / 26mA (typ.) @ 1fix per second
- Small form factor of 15.24 x 15.24 mm² (0.6" x 0.6")
- Support of passive and active antennas
- RF switch for a second GPS antenna (only A1084-A)
- On board antenna supply voltage feed
- Single-sided SMT component, for reflow soldering
- Tape & reel packaging

The A1084 receivers are available as off-the-shelf components, 100% tested and shipped in standard tape-and-reel package.

1.1 Label

The A1084-A labels hold the following information:

Hardware
rr: Hardware Ausgabe / Hardware Release

Software
tt: Software Release
sss: Software Version

Datecode and Location
BZ: Munich / YK: Bicske
ww: Woche / week
yy: Jahr / Year

Figure 1: A1084-A label

The A1084-B's labels show a "B" instead of the "A".

1.2 Characteristics

The modules are characterized by the following parameters.

1.2.1 GPS Characteristics

Channels		20, parallel tracking
Correlators		200,000 plus
Frequency		L1 (= 1,575 MHz)
Tracking Sensitivity (external active antenna)		-159 dBm
Position Accuracy	Stand alone	< 10 m CEP (SA off)
Horizontal Position Accuracy	Stand alone	< 2.5 m CEP (SA off)
Time To First Fix – TTFF (theoretical minimum values; values in real world may differ)	Obscuration recovery (1)	0.1 s
	Hot start (2)	< 1 s
	Warm (3)	< 32 s
	Cold (4)	< 35 s

Table 1: A1084 GPS characteristics

(1) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the µs level).
(2) The receiver has estimates of time/date/position and valid almanac and ephemeris data.
(3) The receiver has estimates of time/date/position and recent almanac.
(4) The receiver has no estimate of time/date/position, and no recent almanac.

1.2.2 Mechanical Characteristics

A1084 Mechanical dimensions	Length Width Height	15.24 mm, 0.6” 15.24 mm, 0.6” 2.4 mm, 0.095”
A1084 Weight		1,2 g, 0.042 oz

Table 2: A1084 dimensions and weight

1.3 Handling Precautions

The GPS receiver modules A1084-A/-B are sensitive to electrostatic discharge (ESD). Please handle with appropriate care.

2 Ordering Information

2.1 GPS Receivers A1084

The order number is built as follows:

- **V23993A1084A-xxx**
- **V23993A1084B-xxx**

V23993 stands for Vincotech's wireless and communication products, A1084A for the A1084-A module, A1084B for the A1084-B module. The "xxx" refers to the current firmware version on the module. If no firmware version is referenced in an order, the latest version will be provided.

2.2 Packing of the A1084

The A1084-A/-B GPS modules come in a tape and reel package suitable for pick and place machines.

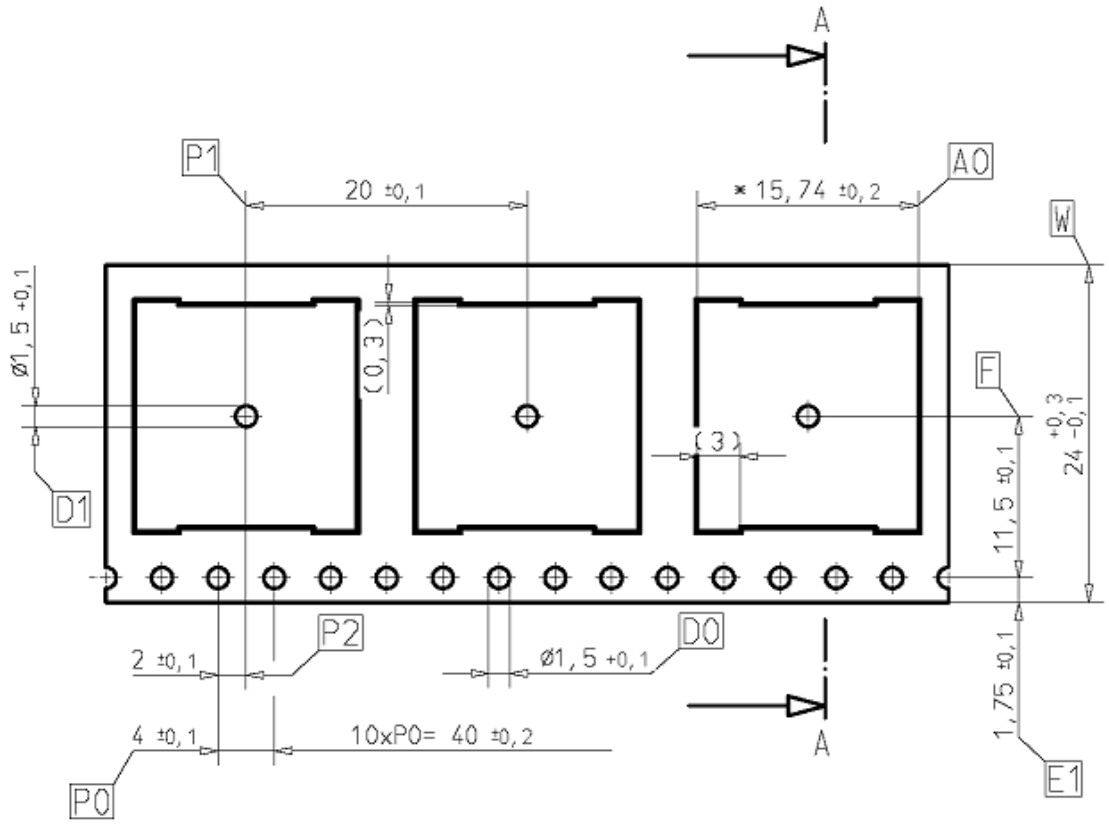


Figure 2: A1084 tape specifications (1)

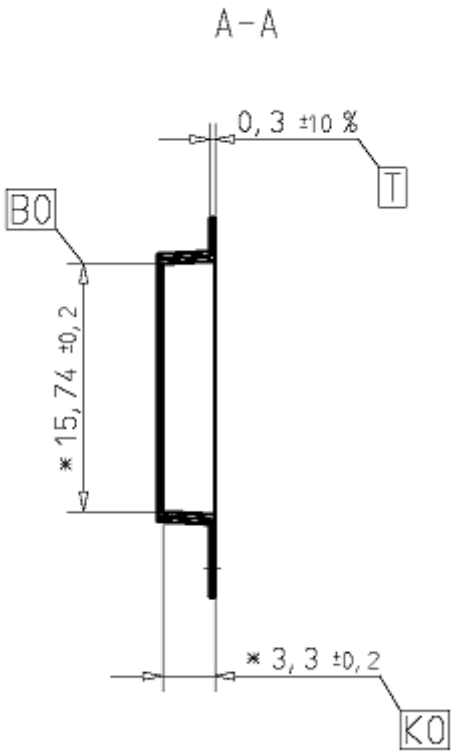


Figure 3: A1084 tape specifications (2)

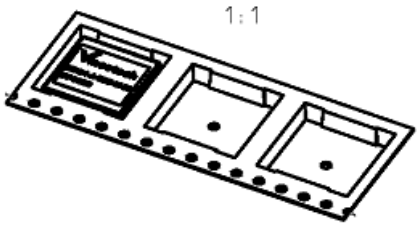


Figure 4: A1084 tape specifications (3)

One complete reel holds 800 A1084 modules.
One box holds three reels.

2.3 Additional Equipment

V23993EVA1084A	Evaluation Kit (including one module V23993A1084A)

Table 3: Additional equipment

A detailed description of the EVA1084-A Evaluation Kit can be found in the appropriate manual.

Note: There is no specific evaluation kit for the A1084-B, distinct from the evaluation kit for the A1084-A, as evaluation kits are designed for demonstration purposes and testing. The GPS parameters for both modules are identical.

3 Quick Start

In order to allow an easy and quick start with the A1084-A and A1084-B modules, this chapter provides a short overview on the important steps to be taken to receive NMEA messages with position information on a serial port.

3.1 Minimum Configuration

The following picture shows a recommended minimum configuration for NMEA output and commands sent and received via an RS232 interface based on the GPS module A1084-A and -B.

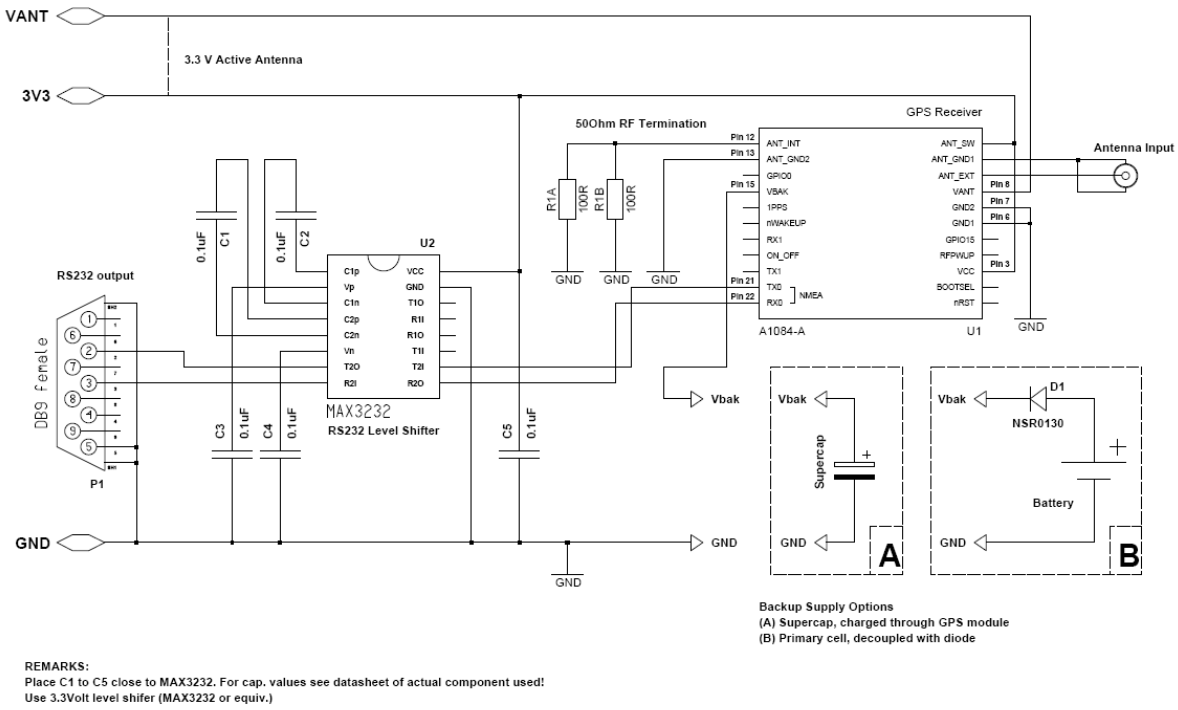


Figure 5: Recommended minimum configuration A1084

Remarks:

- Place C1 to C5 (here: 0.1µF) close to MAX3232. For capacity values see datasheet of actual component used.
- Use 3.3V level shifter (MAX3232 or equivalent).
- Use separate ground plane for antenna ground.
- External antenna input impedance is 50 Ω. Match as close as possible.
- Maximum allowed external antenna current is 50mA. Consider a current limiter.
- A battery back-up circuit for the RTC (Real Time Clock) should be considered (see chapter: “10.6 Battery Back-up”)

3.2 Antennas

Both, active and passive antennas are supported. If an active antenna is used, it is recommended to use one with a supply voltage of 3 to 5 VDC and a current draw of 50 mA maximum. The quality of the GPS antenna chosen (passive or active) is of paramount importance for the overall sensitivity of the GPS system. For passive antennas connected to pin 12 (ANT_INT) special care should be taken on providing an according ground plane! An active antenna connected to pin 9 (ANT_EXT) should have a gain ≥ 20dB and a noise figure ≤ 1.5dB, which applies to more than 95% of the active antennas available in the market. An active antenna connected to pin 12 (ANT_INT) should follow the recommendations given in chapter “8.2.1.2 On Internal / Passive Antenna Input”.

3.3 Serial Port Settings

The default configuration within the standard GPS firmware is:

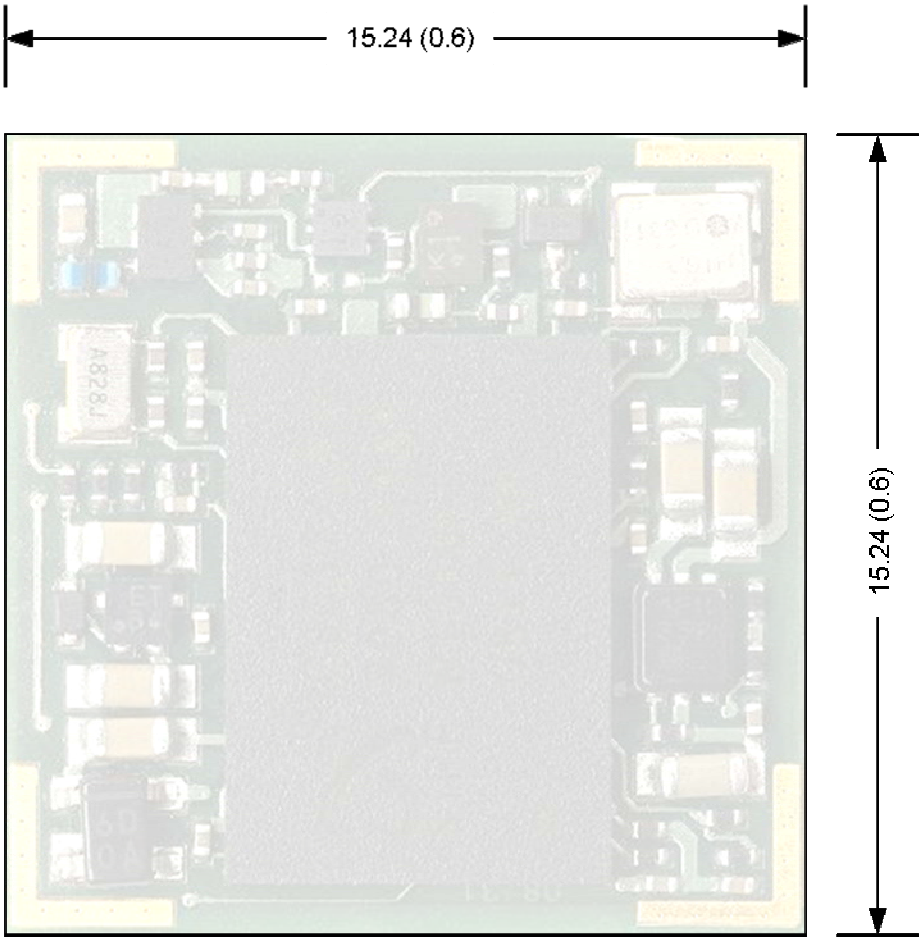
- Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control

3.4 Improved TTFF

In order to improve the TTFF (Time To First Fix), it is recommended to support the RTC with a back-up power when no system power is available.

4 Mechanical Outline

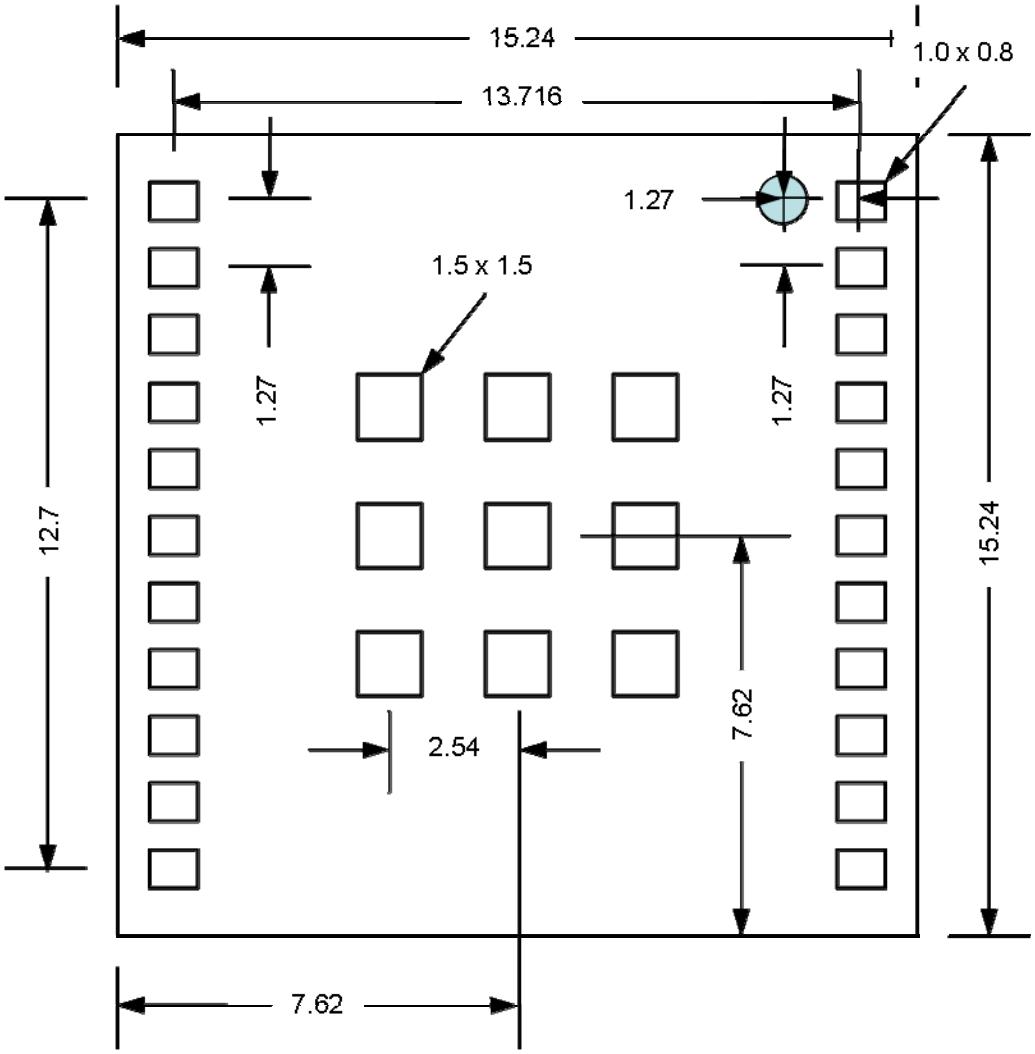
4.1 Details Component Side A1084



All dimensions in [mm, (inch)]

Figure 6: Mechanical outline component side A1084-A/-B

4.2 Details Solder Side A1084



Solder pad size (outer pads): 1.0 x 0.8
Solder pad size (inner pads): 1.5 x 1.5
All dimensions in [mm]

Figure 7: Mechanical outline solder side A1084

5 Pin-out Information

5.1 Layout A1084

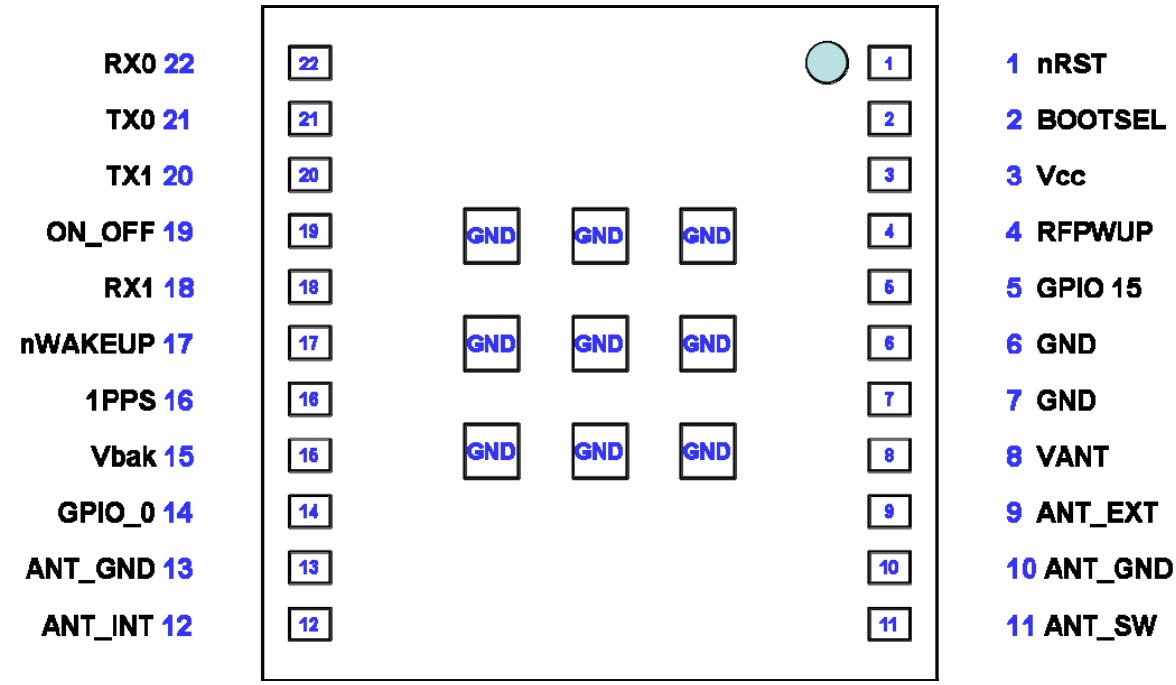


Figure 8: Pin-out information (bottom view) A1084

pin one marker

5.2 Description A1084 Signals

Pin	Symbol	Function	Description
1	nRST	Input	Reset input (open / HIGH – no reset, LOW - reset); see "10.5 Reset Signal"
2	BOOTSEL	Input	Special boot mode – leave open for normal operation; (HIGH – boot loader active)
3	Vcc	Power Supply	3.0 – 3.6 VDC (power supply)
4	RFPWUP	Output	Status of analog section (LOW = OFF, HIGH = ON)
5	GPIO 15	Reserved	Reserved – leave open
6	GND	Power Supply	Ground (power supply)
7	GND	Power Supply	Ground (power supply)
8	VANT	Power supply	Power supply antenna – provide according voltage (up to 5.0 VDC) / **VANT feeds pin 9 ANT_EXT!!!**
9	ANT_EXT	Antenna Input	Antenna signal / Z=50 Ohm (external / active antenna input) **-A version only** **-B version: Do not connect**
10	ANT_GND	RF GND	Antenna Ground, do not connect to GROUND, connect to antenna shield
11	ANT_SW	Input	Antenna switch LOW or Open = internal / passive antenna, pin12 (ANT_INT) input HIGH = external / active antenna, pin 9 (ANT_EXT) **-A version only** **-B version: Do not connect**
12	ANT_INT	Antenna Input	Antenna signal / Z=50 Ohm (internal / passive antenna input) **-A and -B version / see Note (1), (2)**
13	ANT_GND	RF GND	Antenna Ground, do not connect to GROUND, connect to antenna shield
14	GPIO 0	Output	Antenna supply status (SIRF chip), Antenna supply voltage can be switched off
15	Vbak	Power Supply	Back-up pin of module for "super cap" or battery (see below)
16	1PPS	Output	1PPS (pulse per second) output
17	nWAKEUP	Output	Status of digital section (Low = ON, High = OFF) Open Drain with internal pull-up (100k), can not source current!
18	RX1	Input	Serial input 1 – unused in current firmware (leave open)
19	ON_OFF	Input	-ON_OFF, used in PTF mode to request a fix by toggling from LOW to HIGH -ON_OFF, used to switch to hibernate mode and back -leave open if not used
20	TX1	Output	Serial output 1 – unused in current firmware (leave open)
21	TX0	Output	Serial output 0, NMEA out
22	RX0	Input	Serial input 0, NMEA in

Table 4: Pin description A1084

Note (1):
In the event that an active antenna is connected to pin 12, ANT_INT the antenna supply voltage has to be fed separately (see chapter “8.2.1.2 On Internal / Passive Antenna Input”).

Note (2):
An active antenna connected to pin 12, ANT_INT must not exceed a gain of 10dB + antenna cable loss according to SIRF recommendation (see chapter “8.2.1.2 On Internal / Passive Antenna Input”).

5.3 General Comments

The following comments should be considered for a design using either the A1084-A or A1084-B module:

- Standard configuration of serial port (standard GPS software):
  Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Antenna (antenna connected to antenna pin)
  Use ground pins (pin 10, pin 13) close to the antenna input for RF ground.

6 Electrical Characteristics

6.1 Operating Conditions

Pin	Description	Min	Typical	Max
15	V_{bak}	1.8V		3.6V
	Standby Current (4)		20µA	
3	V_{cc}	3.0V	3.3V	3.6V
	Peak Acquisition Current (1)		35mA	
	Average Acquisition Current (2)		31mA	
	Tracking Current (3)		26mA	

Table 5: A1084 electrical characteristics

(1) Peak acquisition current is characterized by millisecond bursts above average acquisition current
(2) Average current is typically only the first two seconds of TTFF
(3) Tracking current typically includes tracking and the post acquisition portion of TTFF
(4) During standby state: RTC block and core powered on and clock off.

6.2 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
Vcc	power supply	-0.3	+3.6	V
Vin	voltage to any pin	-0.3	+3.6	V
Iov	input current on any pin	-10	10	mA
Itdv	absolute sum of all input currents during overload condition		200	mA
Tst	storage temperature	-40	85	°C
Vant	antenna supply voltage	0	5.5	V
Iant	antenna supply current	0	50	mA

Table 6: Absolute maximum ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

6.3 DC Electrical Characteristics

Symbol	Parameter	Min	Max	Unit
1PPS, TX1, TX0,RFPWUP, nWAKEUP, GPIO 0	Voh	2.6	Vcc	V
	Vol		0.2	V
RX1, RX0	Vih	2.0	Vcc	V
	Vil		0.8	V
nRST	for safe reset		0.2	V
ON_OFF	Vih	0.84	1.5	V
	Vil	-0.3	0.36	V
BOOTSEL	Vih	2.3	Vcc	V
ANT_SW	Vih	2.0		V
	Vil		0.2	V

Table 7: DC electrical characteristic

7 Mounting

This chapter describes the suggested mounting process for the A1084-A and A1084-B receiver modules. In a RoHS compliant product with a RoHS compliant process it is recommended to use chemical tin as the counter-part to the module's pins. This will guarantee highest resistance against shocks.

7.1 Proposed Footprint for Soldering

Following soldering footprint parameters are recommended:

- Copper and solder paste footprint are identical
- Pad-shape / -size, inner pads: 1.5mm x 1.5mm
- Pad-shape / -size, outer pads : 1.0mm x 0.8mm
- Stencil thickness of 120 - 150µm

7.2 Recommended Profile for Reflow Soldering

Typical values for reflow soldering of the module in convection or IR/convection ovens are as follows:

Peak temperature (RoHS compliant process)	245°C
Average ramp up rate to Peak (183°C to Peak)	3°C / second max.
Preheat temperature 125 (±25°C)	120 seconds max.
Temperature maintained above 183°C	60 … 150 seconds
Time within 5°C of actual peak temperature	10 … 20 seconds
Ramp Down rate	6°C / second max.
Time 25°C to peak temperature	6 minutes max.

Table 8: Reflow soldering profile A1084

As results of soldering may vary among different soldering systems and types of solder and depend on additional factors like density and types of components on board, the values above should be considered as a starting point for further optimization.

8 Use of GPS Antennas

8.1 Connecting a GPS antenna to the GPS receiver

The ANT_EXT or ANT_INT pin is used to connect a GPS antenna to the receiver. The design of the antenna connection has to be done strictly according to RF design rules. A 50Ω PCB strip line is required. The following drawings shall explain the guidelines. A major rule is to keep the strip line as short as possible. Additionally, antenna ground (ANT_GND) should be routed to the ground plane of the PCB (the ground plane is on a lower PCB layer) by vias as demonstrated in the drawing.

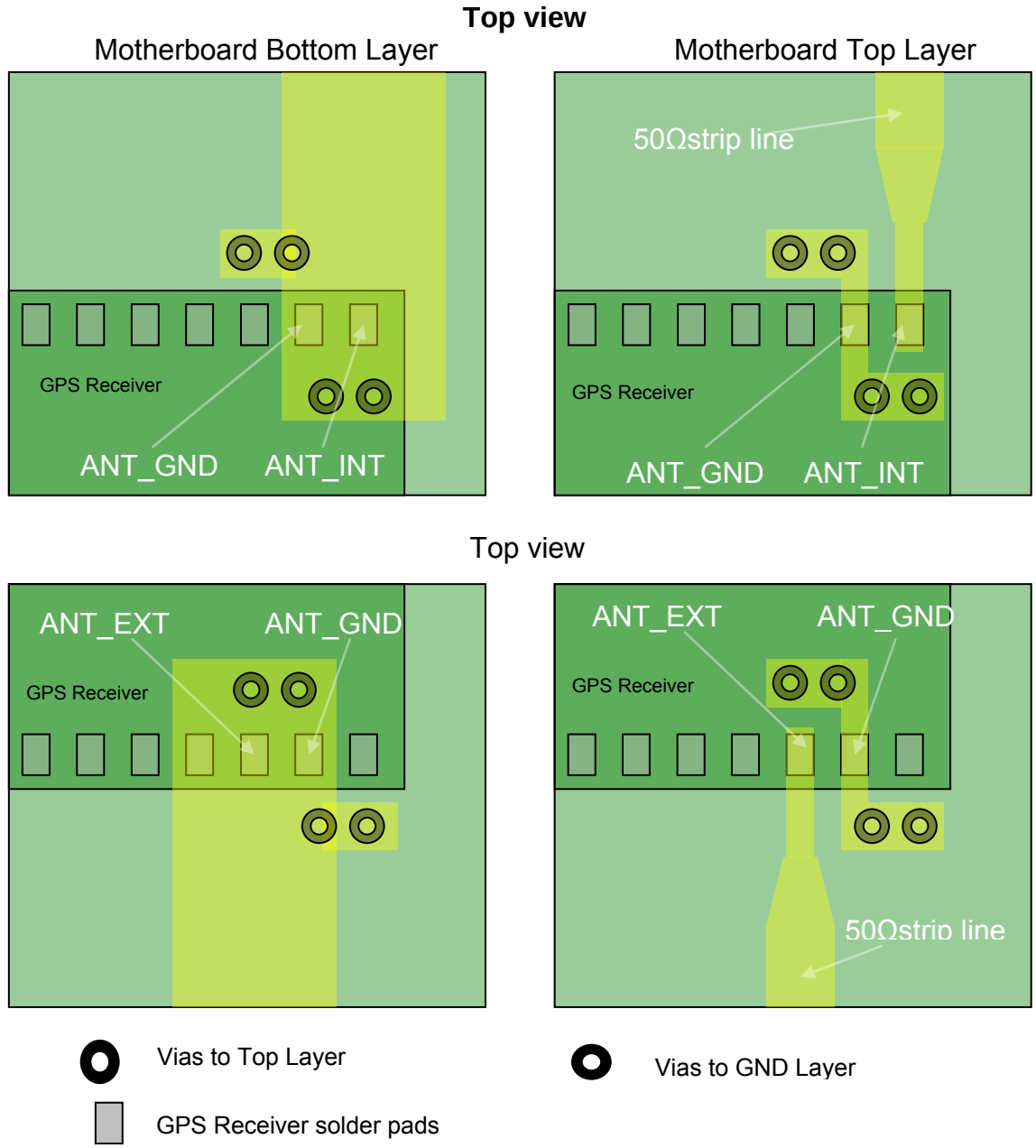


Figure 9: Antenna connector strip line A1084

In order to achieve the impedance of 50 Ω, the width of the strip line needs to be calculated. It depends on the thickness or height of the PCB layer (both parameters are shown in following drawing). For the calculation, it is assumed that the PCB material is FR4.

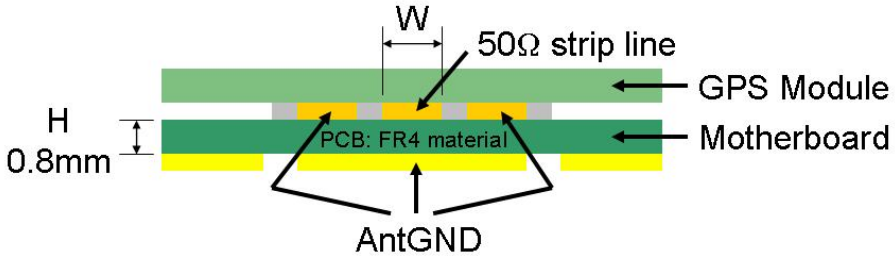


Figure 10: Strip line parameters A1084

In this case, the width should be about 1.8 times the height of the PCB:

$$W = 1.8 \times H$$

In the example, one would get a width of W = 1.8 x 0.8 mm = 1.44 mm.

8.2 Antenna Connections

8.2.1 Active Antennas

8.2.1.1 On External / Active Antenna Input (ANT_EXT)

General GPS active antenna specification:

Limitations:

- Supply voltage (voltage fed into VANT pin) 5V (max.)
- Supply current 50mA (max.)

Recommendations:

- Gain ≥ 20dB (should not exceed 26dB + cable loss)
- Noise figure ≤ 1.5dB

The recommendations apply to the majority of active antennas that can be found in the market. Anyhow, the quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system.

The system design needs to reflect the supply voltage of the antenna. If the supply voltage is equal to Vcc, Vcc can be connected to VANT. If the antenna requires a different supply voltage, the antenna bias can be provided through the VANT pin.

8.2.1.2 On Internal / Passive Antenna Input (ANT_INT)

This schematic is a part of the EVA1084-A (Evaluation Kit) schematics. It shows how an antenna supply voltage can be fed to an active antenna connected to ANT_INT and how the antenna supply voltage can be switched on and off by RFPWUP.

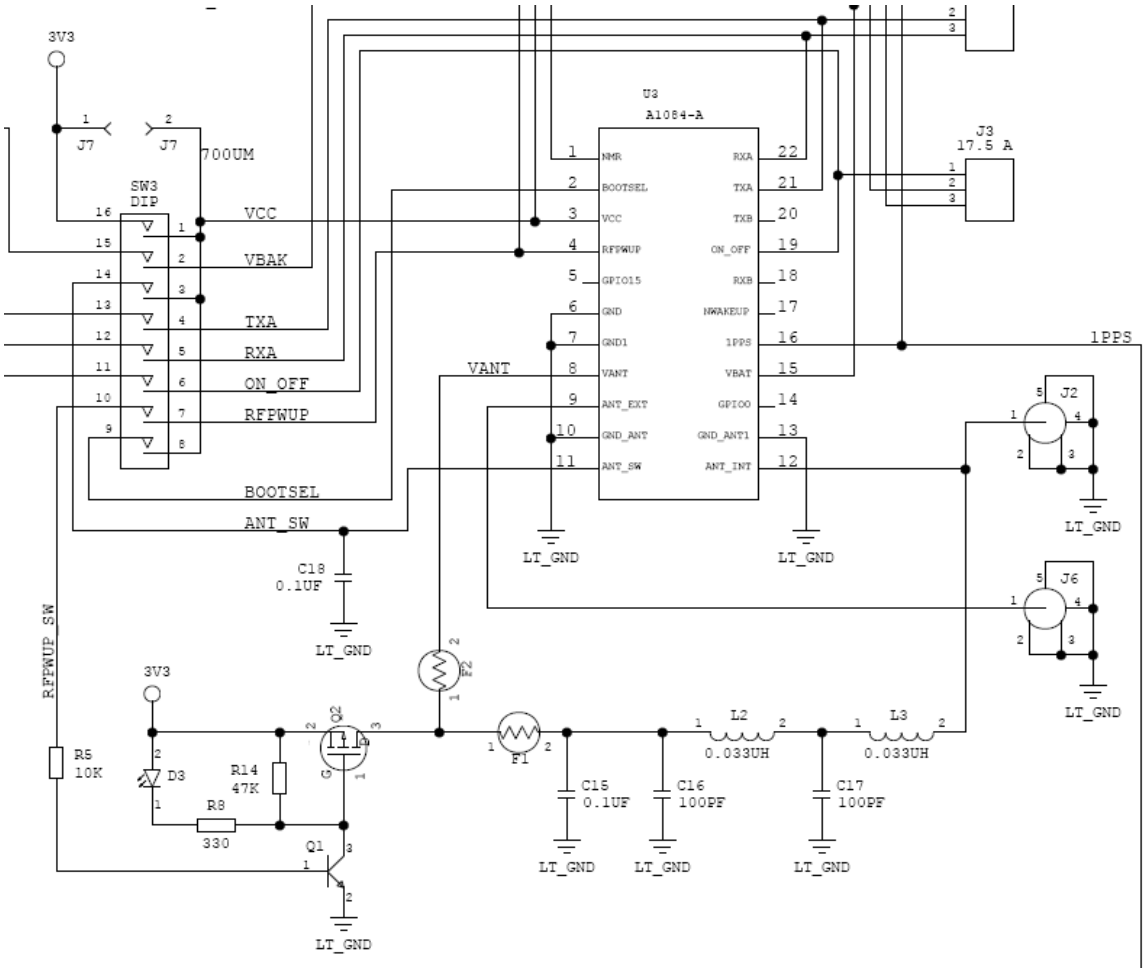


Figure 11: Antenna supply voltage for ANT_INT

An active antenna connected to pin 12, ANT_INT must not exceed a gain of 10dB + antenna cable loss according to SIRF recommendation. Exceeding this gain recommendation should be tested case by case.

8.2.2 Passive Antennas

A passive antenna connected to **ANT_INT** should be placed as close as possible to the GPS receiver. The signal power lost by the antenna cable or lost by the stripline on the PCB can not be recovered by the LNA (Low Noise Amplifier) integrated in the GPS receiver.

A suitable Ground-Plane design should be considered depending on the antenna type connected to ANT_INT.

8.2.3 Hints

Unused antenna inputs should be terminated with 50 Ω ± 20%. Do not feed antenna supply voltage into terminated antenna inputs

9 Quality and Reliability

9.1 Environmental Conditions

Operating temperature	-30°C … +85°C
Operating humidity	Max. 85% r. H., non-condensing, at 85°C
MSL JEDEC (Moisture Sensitivity Level)	3
Storage	6 months in original package.

Table 9: Environmental conditions

9.2 Product Qualification

Prior to product qualification the GPS receiver is preconditioned according to EIA/JEDEC standard JESD22-A113-B / Level 3.

Basic qualification tests:

- MSL Classification according to J-STD-020C (MSL3 @ 245°C)
- MSL Rework Compatibility according to J-STD-020C
- Temperature Cycling –30°C … +85°C
- Temperature Humidity Bias 70°C / 85% RH
- Low / High Temperature Operating –30°C / +85°C
- High Temperature Operating Life +85°C
- Vibration Variable Frequency
- Mechanical Shock

Please contact Vincotech for detailed information.

9.3 Production Test

Each module is electrically tested prior to packing and shipping to ensure state of the art GPS receiver performance and accuracy.

10 Applications and Hints

10.1 Minimum Configuration

Please refer to chapter “3.1 Minimum Configuration” for details. In addition, for optimized start-up behavior it is strongly recommended to add a battery back-up circuit (see chapter “10.6 Battery Back-up”)!

10.2 Antenna Status Adaptation

This chapter shall give assistance in designing a circuit for detecting if an antenna is connected to the module. The information about the antenna status can be derived from the ANTSTAT signal generated by this circuit. The examples use values for components that roughly result in the following ANTSTAT output:

- Logic low when: Iant < 9mA
- Logic high when: 9mA > Iant < 16mA
- Logic low when: Iant > 16mA

10.2.1 Antenna Sensor

The following circuit is a proposal on how you can feed an antenna with 3.3V and provide an output for the ANTSTAT pin. The value of the components may need an adaptation in the final application. For example, the input current of the chosen comparator goes into that equation. The thresholds defined in this circuit are quite close to the ones described above. Their value is determined by resistors R4, R5, and R3.

We strongly recommend simulating and testing the GPS receiver integrated in your product design before implementing the finalized product in the appropriate market application.

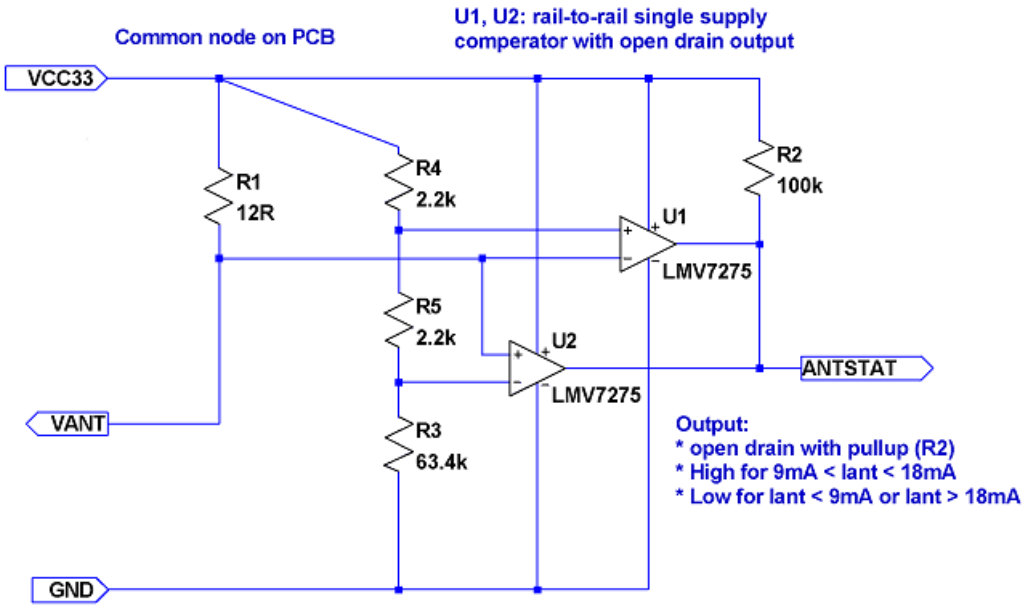


Figure 12: Application note: Antenna sensor adaptation

10.2.2 Antenna Sensor with Current Limiter

This proposal is similar to the first one, but includes a current limiter. Comments and notes as above apply.

We strongly recommend simulating and testing the GPS receiver integrated in your product design before implementing the finalized product in the appropriate market application. In any case it is the responsibility of the designer to test and verify the implementation.

Current Limiter

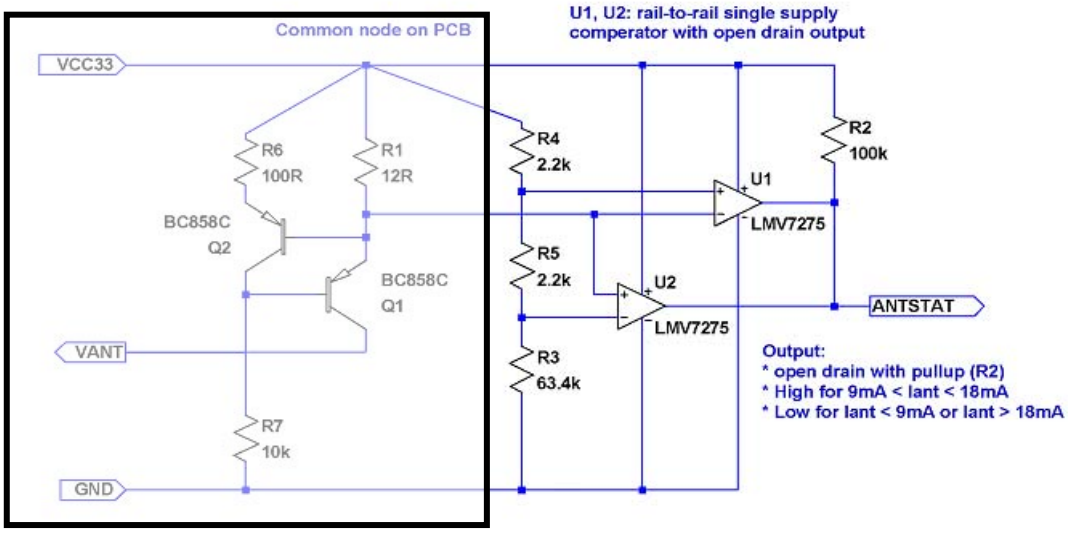


Figure 13: Application note: Antenna sensor adaptation with current limiter

10.3 VANT Pin (antenna voltage input pin)

The VANT pin is an input pin.

The supply voltage for an active GPS antenna on the ANT_EXT input has to be fed into the Vant pin. The easiest way to do that is to connect Vcc to VANT. The maximum current is 50 mA.

Note: Shortcut between ANT and GND may damage the A1084-A/-B GPS receiver module. This should be avoided by using an antenna current limiter.

The circuit (chapter “10.2.2 Antenna Sensor with Current Limiter”) works for Vcc from 3V to 5V. The antenna current will be limited to 50 mA approximately.

If other transistors are used, other resistor values may be necessary as well. We strongly recommend simulating and testing your realized version before using it.

10.4 1PPS Pin (1 pulse per second pin)

The 1PPS pin is an output pin.

In addition to precise positioning, GPS also allows for accurate timing due to the synchronized atomic clocks in the GPS satellites. While the current date and time is transmitted in NMEA sentences (UTC), an exact and accurate timing signal is provided via the 1PPS pin of the A1084 GPS receiver.

Under good signal conditions the 1PPS signal comes between 620ns and 710ns after the full GPS system second which is accurately (around 10ns) synchronized to UTC. Therefore the 1 second clock can be derived and maintained within around 90ns under good signal conditions.

Note: The 1PPS clock accuracy directly depends on the position accuracy! The GPS signals travel at the speed of light, therefore a position inaccuracy directly translates into 1PPS inaccuracies.

10 m position deviation ≈ 33 ns 1PPS deviation (typically)
100 m position deviation ≈ 333 ns 1PPS deviation (typically)

The NMEA messages containing absolute timing information (UTC time) are pro-vided around 300 ms after the 1PPS signal, typically. This may change according to the setup of the GPS receiver.

The 1PPS signal is provided on an “as is” basis with no accuracy specification. The given values are based on a 10 satellite, static GPS simulator scenario.

10.5 Reset Signal

The nRST pin is an input pin.

The nRST pin can be used to generate a reset on the A1084-A/-B module. Resetting the module will result in a restart of the complete firmware. All information stored in SRAM will still be valid.

10.5.1 Internal Reset Circuit

The A1084 is already equipped with a voltage monitoring device that generates a proper power-on reset at the appropriate threshold and delay. Additionally it takes care about the brown-out protection. Usually there is no need to deal with the reset input externally, thus the general advice is to leave this pin open.

10.5.2 External Reset Circuit

If – for some reasons – an external reset input is really desired, the following instructions are recommended:

Only use an open drain/collector device (e.g. a bipolar NPN transistor to ground, see below) to pull the nRST pin low in order to issue a reset.

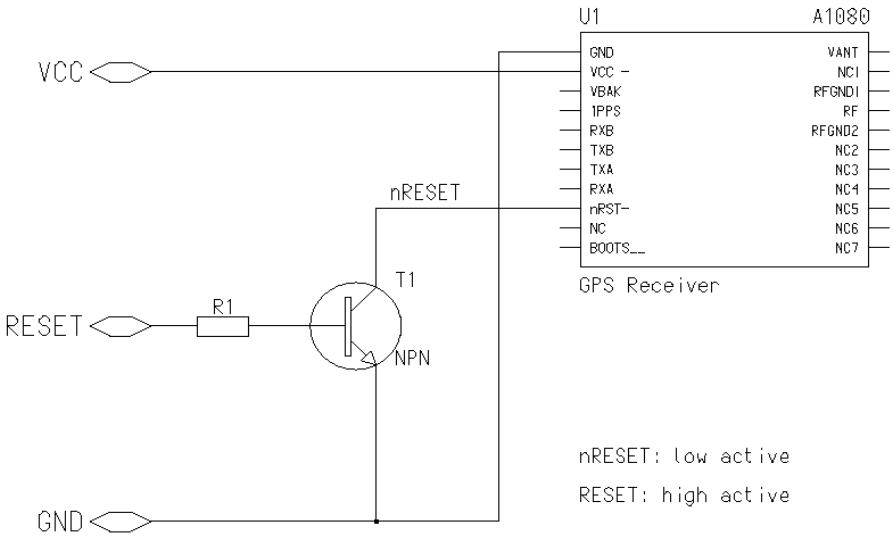


Figure 14: Application note: Recommended external reset circuit

10.6 Battery Back-up

This application note describes how to back-up the RTC and the SRAM of the GPS receiver module. The basics of the first example addresses providing a back-up power supply by using a separate battery or a “Supercap”.

While the “Supercap” is charged thru the module during normal operation, the battery (primary cell) is decoupled thru a diode!

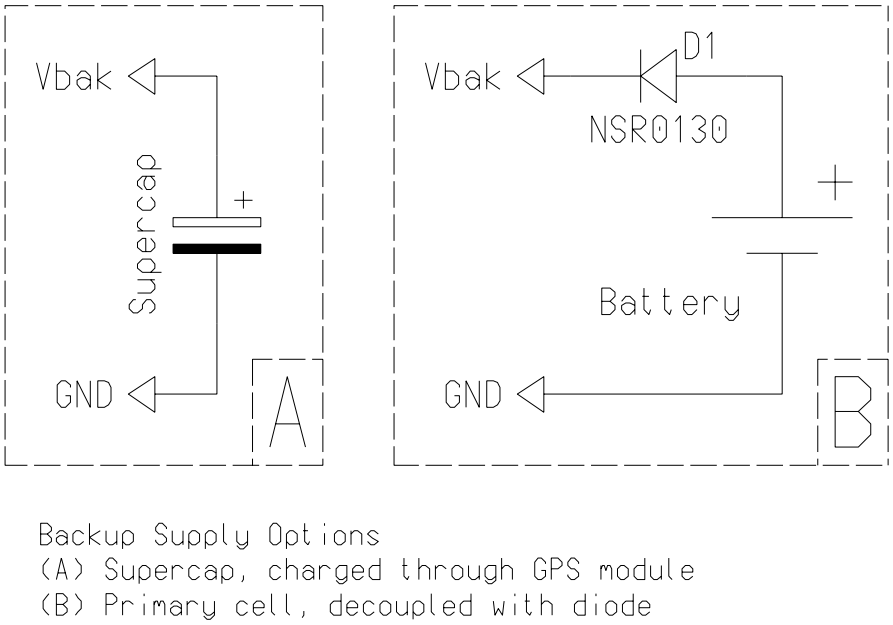


Figure 15: Application note: Module back-up

An alternative to this solution is to switch the supply voltage from the Vcc pin to the Vbat pin. Care needs to be taken that there is no voltage outage during the switch-over phase!

The Vbak pin draws 20 µA typically.

10.7 Push-to-Fix Mode

Push-to-Fix mode is designed for the application that requires infrequent position reporting. The receiver generally stays in a low-power mode, up to 2 hours, but wakes up periodically to refresh position, time, ephemeris data and RTC calibration.

The push-to-fix mode is initialized and entered using the SiRF Binary Protocol. Please refer to the appropriate manual, paying particular attention to the paragraph titled “Set TricklePower Parameters”. In order to request a fix outside the specified duty cycles, it is necessary to toggle the pin ON_OFF. Toggling is done by pulling the signal to HIGH for about 100ms.

(see also AppNote Firmware A1080)

10.8 Hibernate Mode

From Firmware version 3.2.5, firmware support for ON_OFF has been included, hence, a rising pulse on the ON_OFF pin will put the A1084 GPS receiver into hibernate state if it is on and wake up if it is in sleep state. During sleep state the receiver draws 20 µA typically and maintains RTC and SRAM.

11 Evaluation Kit EVA1084-A

For demonstration and easy evaluation of GPS performance Vincotech offers an evaluation kit (including one GPS A1084-A module). It contains a USB interface with according drivers to connect easily to a PC. The USB interface is an extension of the serial port 0, therefore sending NMEA sentences and accepting commands. At the same time it provides power to the module. Accompanied by an antenna it offers a ready-to-go set.

For the development of new software and applications the Evaluation Kit also provides NMEA messages on CMOS level via a terminal plug.

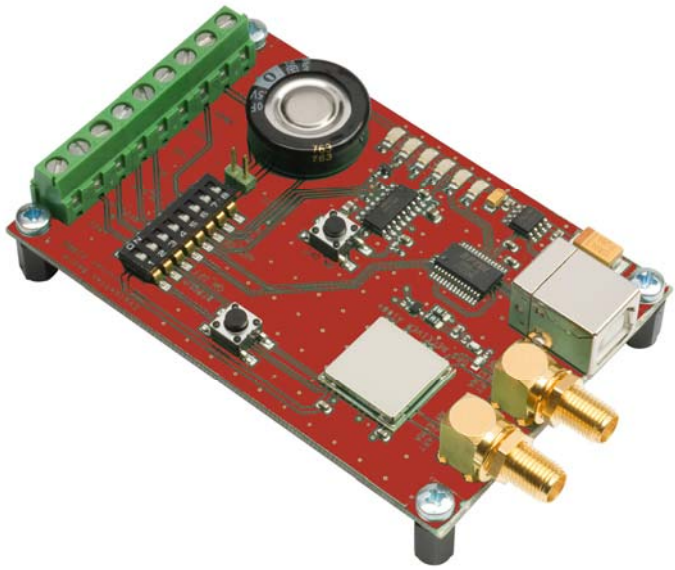


Figure 16: Evaluation kit EVA1084-A

For further information please contact Vincotech.

12 Related Information

12.1 Contact

This manual was created with due diligence. We hope that it will be helpful to the user to get the most out of the GPS module.

Inputs regarding errors or mistaken verbalizations and comments or proposals to Vincotech, Germany, for further improvements are highly appreciated.

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12.2 Related Documents

- GPS Firmware A1080 (Vincotech)
- GPS Evaluation Kit EVA1084-A (Vincotech)
- SiRF_Binary_Reference_Manual (SiRF)
- SiRF_NMEA_Reference_Manual (SiRF)
- GPS AppNote nRST A1080 (Vincotech)
- GPS AppNote 1PPS Pulse Width (Vincotech)
- GPS AppNote EDLC-Backup A1080 (Vincotech)
- GPS AppNote Backup A1080 (Vincotech)
- GPS AppNote GeoHelix Antenna A1080 (Vincotech)
- GPS AppNote Firmware A1080 (Vincotech)

12.3 Related Tools

- GPS Cockpit (Vincotech)
- SiRF Demo (SiRF)
- SiRF Flash (SiRF)

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